M-PULSe™

For Frac Water Batching
Application Guide
P/N 1-0561-049

Revision A

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Application Guide
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Revision History

Revision Level	Date	Comments
A	05-10	Initial release (ERO 7374).

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Contents

Chapter 1 Application Overview 1-1
Introduction 1-1
Background 1-1
Flow Charts 1-2
Using this Application Guide 1-6
Associated Documentation 1-6

Chapter 2 Local User Interface 2-1

Chapter 3 AutoMPULSe Frac Water Batch Configuration 3-1

Chapter 4 Batch History Records 4-1

Chapter 5 Batch Log Collection 5-1
Batch Record Index 5-1
Batch Record Collection 5-2
Frac Water Outputs and Inputs 5-4
Additional Modbus Registers 5-5

Chapter 6 Getting Help 6-1

Index INDEX-1

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Chapter 1
Application Overview

Introduction

The Thermo Scientific M-PULSe™ flow computer application code has been modified to perform the requirements for frac water batching. This application guide details the functionality of the batching procedure along with the configuration and setup of the M-PULSe to both perform and retrieve batch data.

Note This guide contains information specific to frac water batching. For information on standard M-PULSe operation, reference the M-PULSE user guide (P/N 1-0561-022). ▲

Background

A requirement exists to collect fresh water from a variety of state approved sites for injection at various well sites. The water is then delivered to the well sites where it is stored, injected, and partially recovered. State permits dictate that a maximum volume (e.g. 107,000 gallons) may be withdrawn from any one collection site per day and large fines are levied against companies exceeding the state permits. Volumes extracted must be accurately recorded along with delivered and recovered volumes for daily reconciliation.

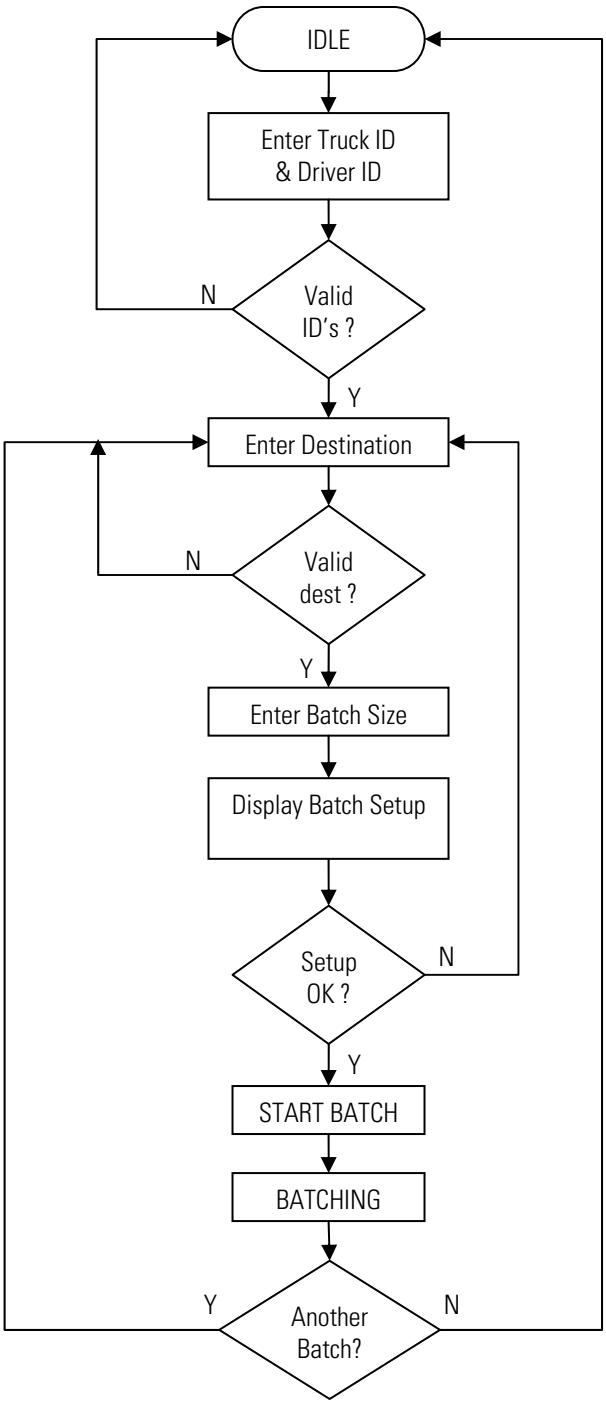
The M-PULSe flow system has been modified to monitor the abstraction of fresh water from a collection site and provide information of volumes each time a batch of water is collected.

Flow Charts

General Operation – Batches Allowed after Daily Volume Exceeded

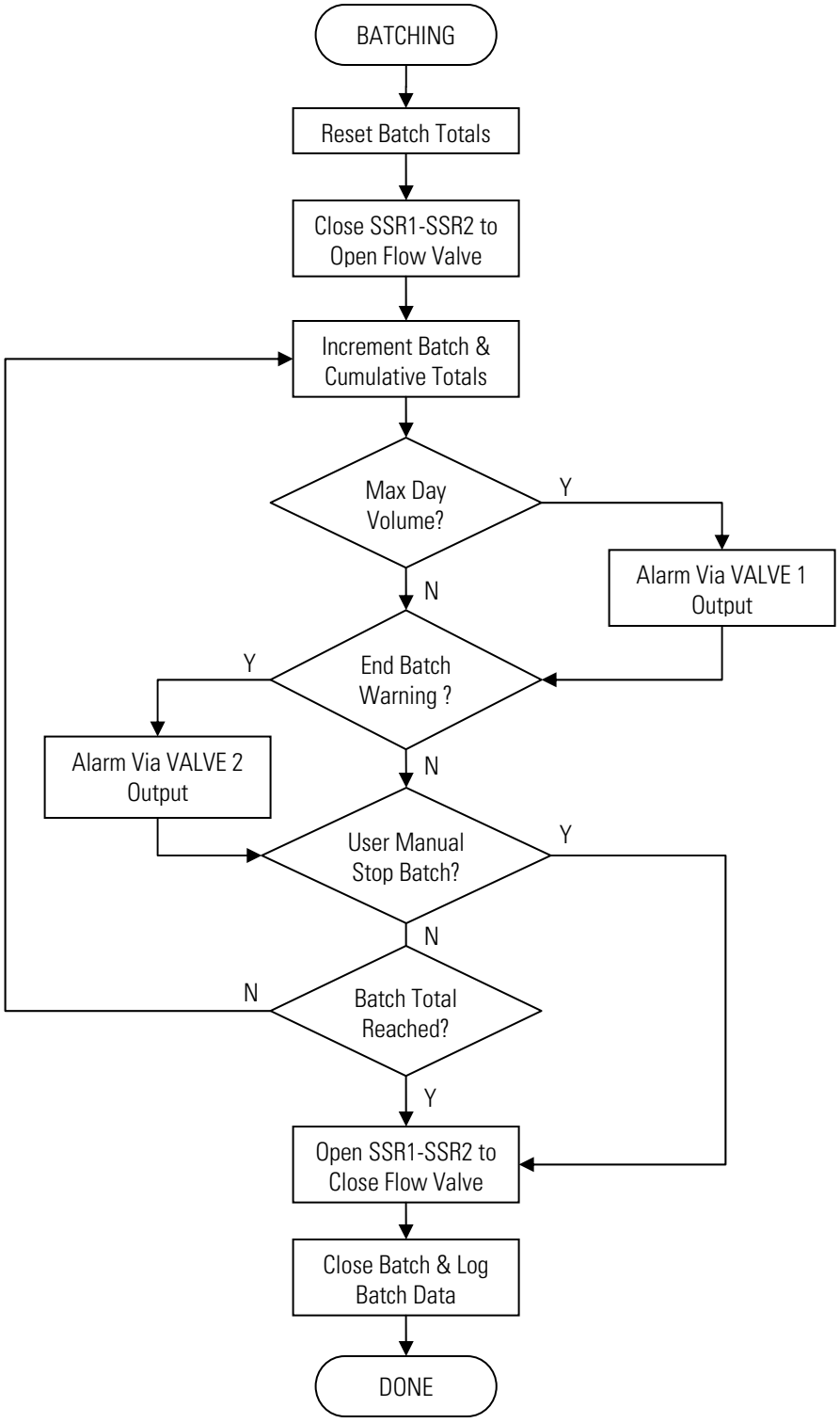
The batch setup/control is performed solely from the front panel keypad/LCD display.

Below is a flow chart of how the frac water system operates within the M-PULSe flow system.



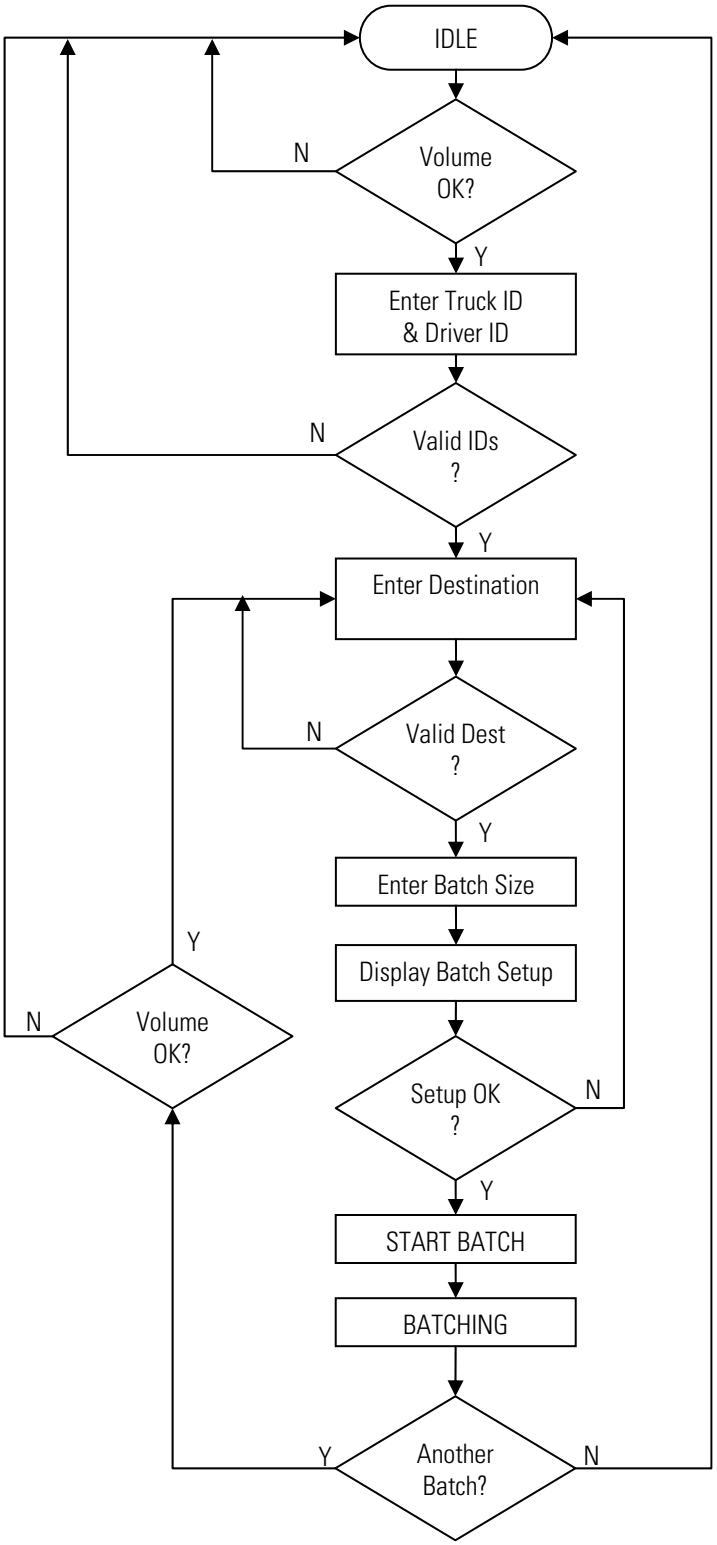
Batching – Batches Allowed after Daily Volume Exceeded

The following flow chart defines the operations performed by the M-PULSe when a batch is started locally by a driver.



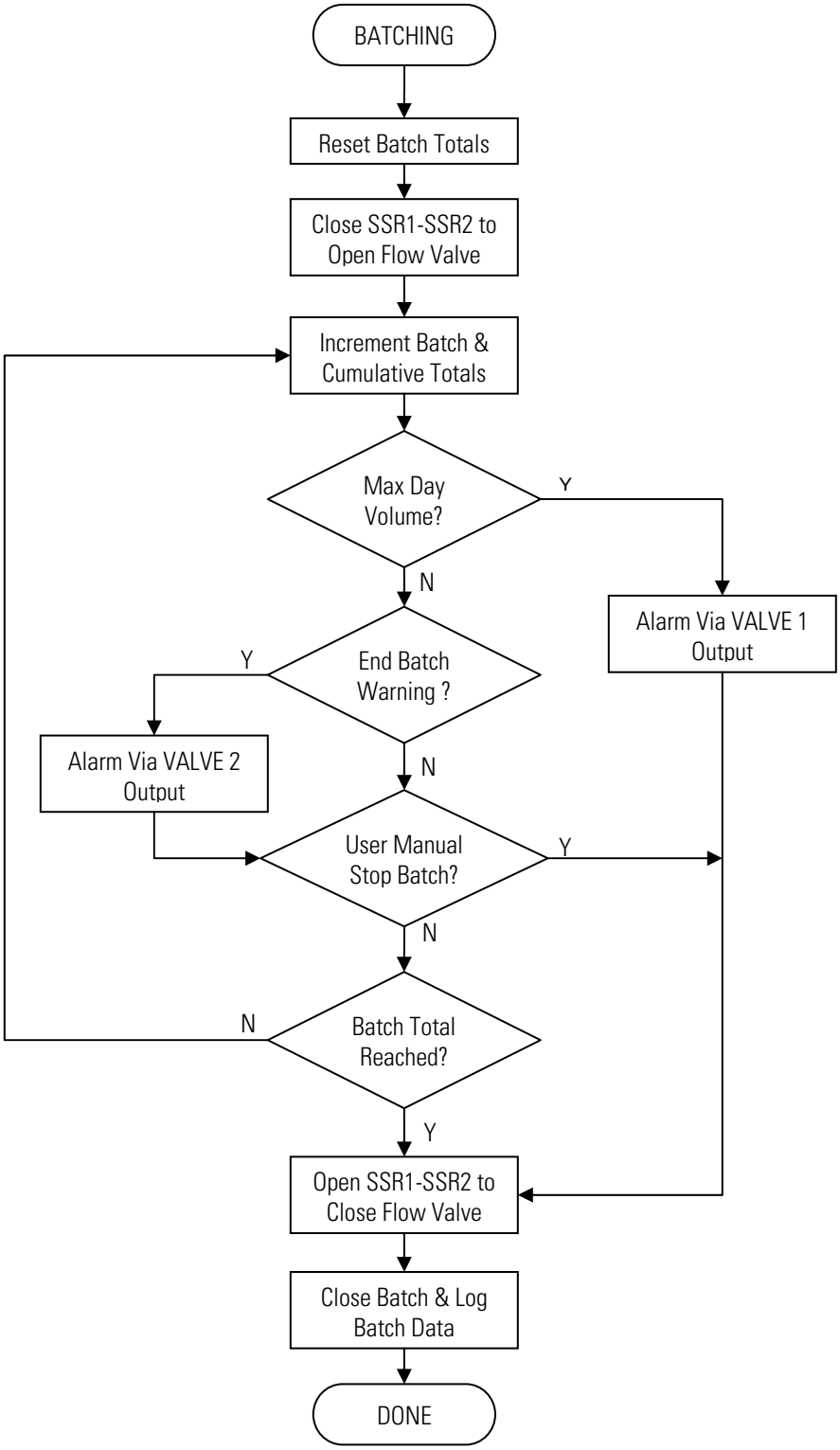
General Operation – Batches Inhibited after Daily Volume Exceeded

Below is a flow chart of how the frac water system operates within the M-PULSe flow system.



Batching – Batches Inhibited after Daily Volume Exceeded

The following flow chart defines the operations performed by the M-PULSe when a batch is started locally by a driver.



Using this Application Guide

This document was created specifically for frac water batching. Refer to the M-PULSe user guide (P/N 1-0561-022) for instructions and details on the standard menu structure and functionality of the M-PULSe.

Associated Documentation

Along with this guide, the following documents must be read and understood by all persons installing, using, or maintaining this equipment:

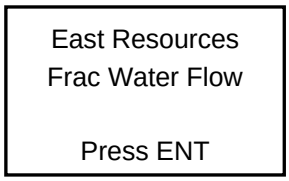
- M-PULSe user guide (P/N 1-0561-022)
- M-PULSe installation guide (P/N 1-0561-023)

Chapter 2
Local User Interface

This section describes how the batching process is controlled via the following sequence of screens using the front panel keypad/LCD display.

Idle screen

When not performing any batch operations, the M-PULSe will display the Idle screen:



When displayed, only the **ENT** key on the keypad will be active.

Should the contrast for the display be such that the screen cannot be viewed, a local operator can use the up [**8**] and down [**2**] arrow keys to adjust the contrast.

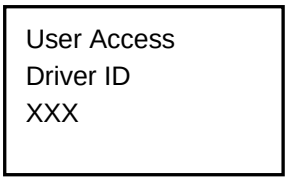
Whilst being configured remotely in Supervisor level or above the Idle Screen will display “Remote” until operator mode is returned by the remote user.

If left in Supervisor mode or above, the mode will return to Operator after the remote user port has been inactive for five minutes. In this case, the M-PULSe display will return to the Idle screen.

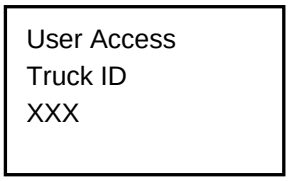
Note Should the volume extracted for the day exceed the user entered maximum volume for the site, the message “Vol. Exceeded!” will flash on the display. In this instance, the M-PULSe will allow a driver to start a batch; however, the batch data will indicate the daily volume extracted from the site so fines can be levied. ▲

User Access screen

After pressing **ENT** on the Idle screen the operator must enter a unique Driver ID and Truck ID as shown in the following screens:



Operator enters the Driver ID and presses **ENT**.

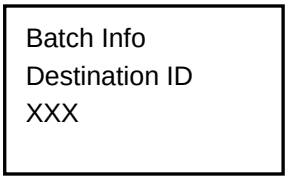


Operator enters the Truck ID and presses **ENT**.

Both IDs will be validated against a pre-programmed list of up to 100 acceptable IDs stored within the M-PULSe database. Should either of the IDs be invalid, the message “Invalid ID!” will be shown before the display returns to the Idle screen.

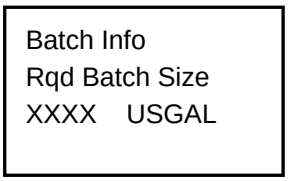
Batch Info Setup

After entering a valid Diver and Truck ID the operator is then asked to set up the required batch in the following sequence.



Operator enters the Destination ID and presses **ENT**.

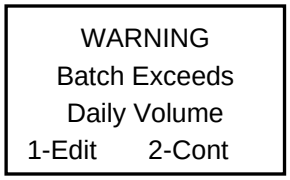
Again, up to 100 allowable destinations for the site are pre-programmed into the M-PULSe. Entry of an invalid destination will require the operator to re-enter the correct Destination ID.



Operator enters the required batch size and presses **ENT**.

Batch Size Warning screen

Should the requested batch size mean that the daily volume will be exceeded the following screen will be displayed.

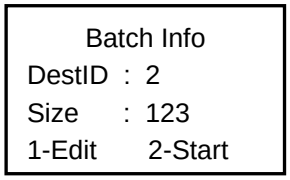


Pressing **1** will return the operator to the batch setup screen.

Pressing **2** will allow the operator to continue the batch and the Batch Info Confirmation screen will be displayed (see next).

Batch Info Confirmation screen

After entry of the destination ID and required batch size the Batch Info Confirmation screen is displayed:



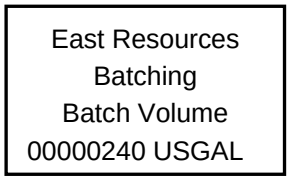
Pressing **1** will return the operator to the batch setup screen should the batch information be incorrect.

Pressing **2** will start the batch.

At this point, the relay controlling the pump [SSR1 – SSR2] will be closed to allow flow through the M-PULSe meter into the truck.

Batching screen

Once a batch has been started the M-PULSe display will indicate the running batch total as the water is extracted from the site as shown below.



During extraction the operator can look additional items as described below.

Pressing **1** will display the current daily volume for the site.

East Resources
Batching
Daily Volume
00010546 USGAL

Pressing **2** will display the remaining daily volume for the site.

East Resources
Batching
Remaining Volume
00010546 USGAL

Pressing **3** will display the cumulative volume for the site.

East Resources
Batching
Cumm. Volume
12310546 USGAL

*This is the volume that has flown through the M-PULSe spool since it was last manually reset to 0.

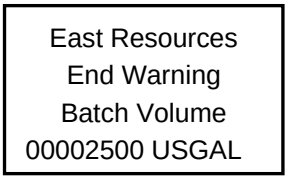
Pressing **4** will display the current flow rate for the batch.

East Resources
Batching
Flow Rate
123.4567 GPM

Note: Pressing **0** will return the display to the current batch volume.

Batch End Warning screen

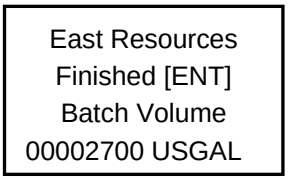
When a batch is set up a warning that the batch is about to end will be displayed to the operator regardless of what variable is being displayed as follows:



At present, this is set when 10% of the required batch size is remaining. When the batch warning is displayed the digital output VALVE2 will be set Hi.

Batch Completion screen

At the end of the batch the display will indicate to the driver that the batch is complete.

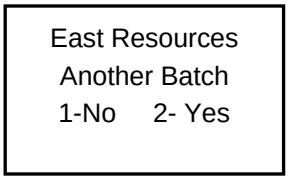


At this point, the relay controlling the pump used for extraction [SSR1 – SSR2] will have opened and the flow rate should have stopped.

"ENT" will be flashing, indicating to the operator that the **ENT** key must be pressed.

Another Batch screen

After pressing **ENT**, the operator is asked whether another batch is required, as shown below.



Pressing **1** will return the display to the Idle screen.

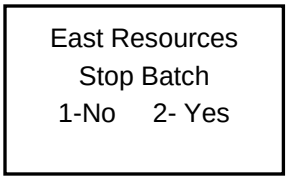
Pressing **2** will return the screen to the Batch Info Setup screen.

Forced Batch Closure

If for some reason a batch is to be closed before completion, the operator can do this via either the front panel keypad or an external button connected to the Sphere 1 digital input.

Keypad Batch Closure

Should it be necessary to close a batch before the required volume has been extracted, pressing the ● key on the keypad will display the following screen:



Pressing **1** will return the display to the Batching screen and continue with the batch.

Pressing **2** will confirm batch closure and force the batch to be completed.

Again after the batch is closed the operator will be asked if another batch is to be performed.

External Input Batch Closure

An option to connect a button to the M-PULSe Sphere input is also available to force a batch closure. If connected pressing the button will force the batch to be closed immediately.

Max Daily Volume Exceeded

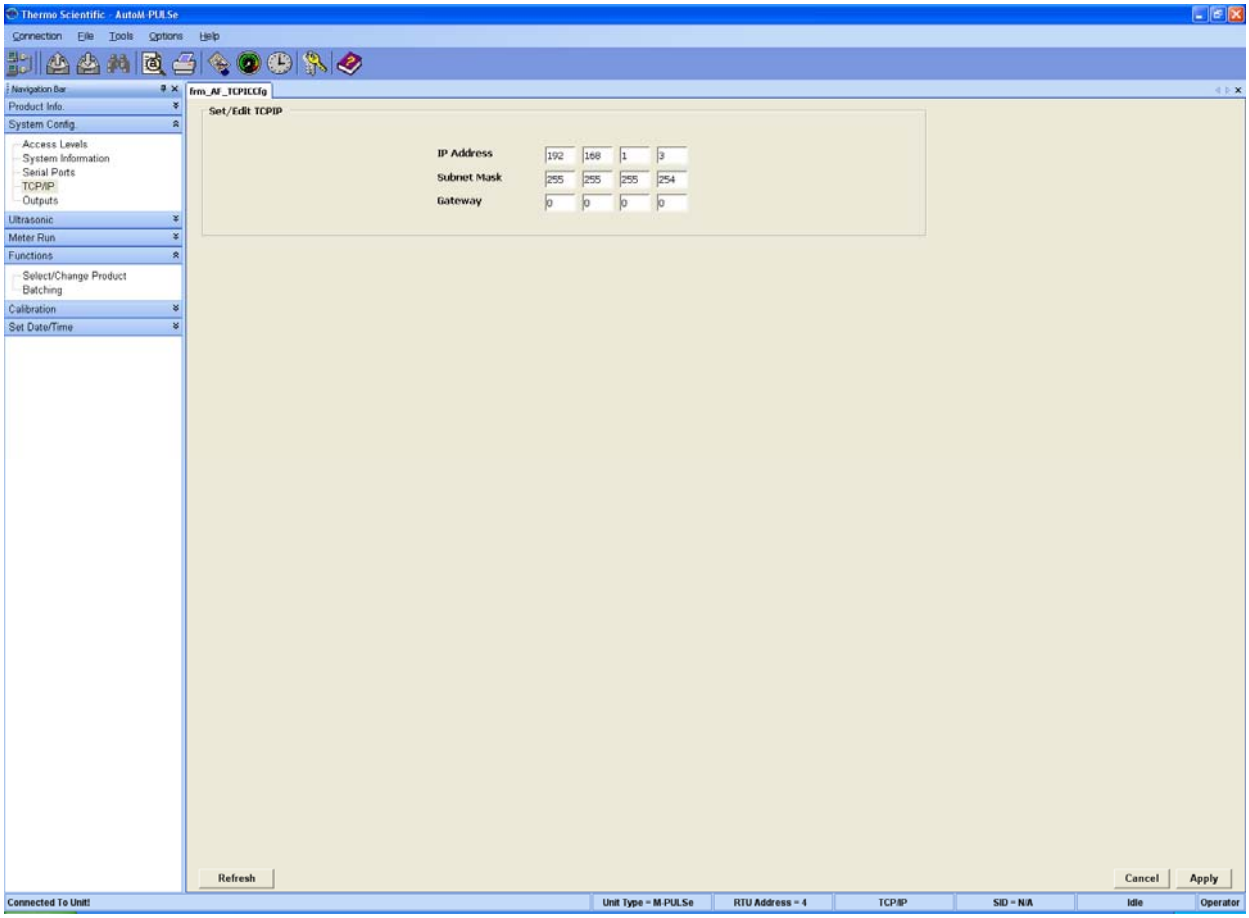
Should the extracted volume for the day exceed the user entered maximum allowed daily volume then the digital output VALVE1 will be set Hi.

Chapter 3
AutoMPULSe Frac Water Batch Configuration

AutoMPULSe configuration software has been modified to enable the frac water batch parameters to be configured prior to operation in the field. This section details the new screens that have been designed for this purpose.

TCP/IP Configuration

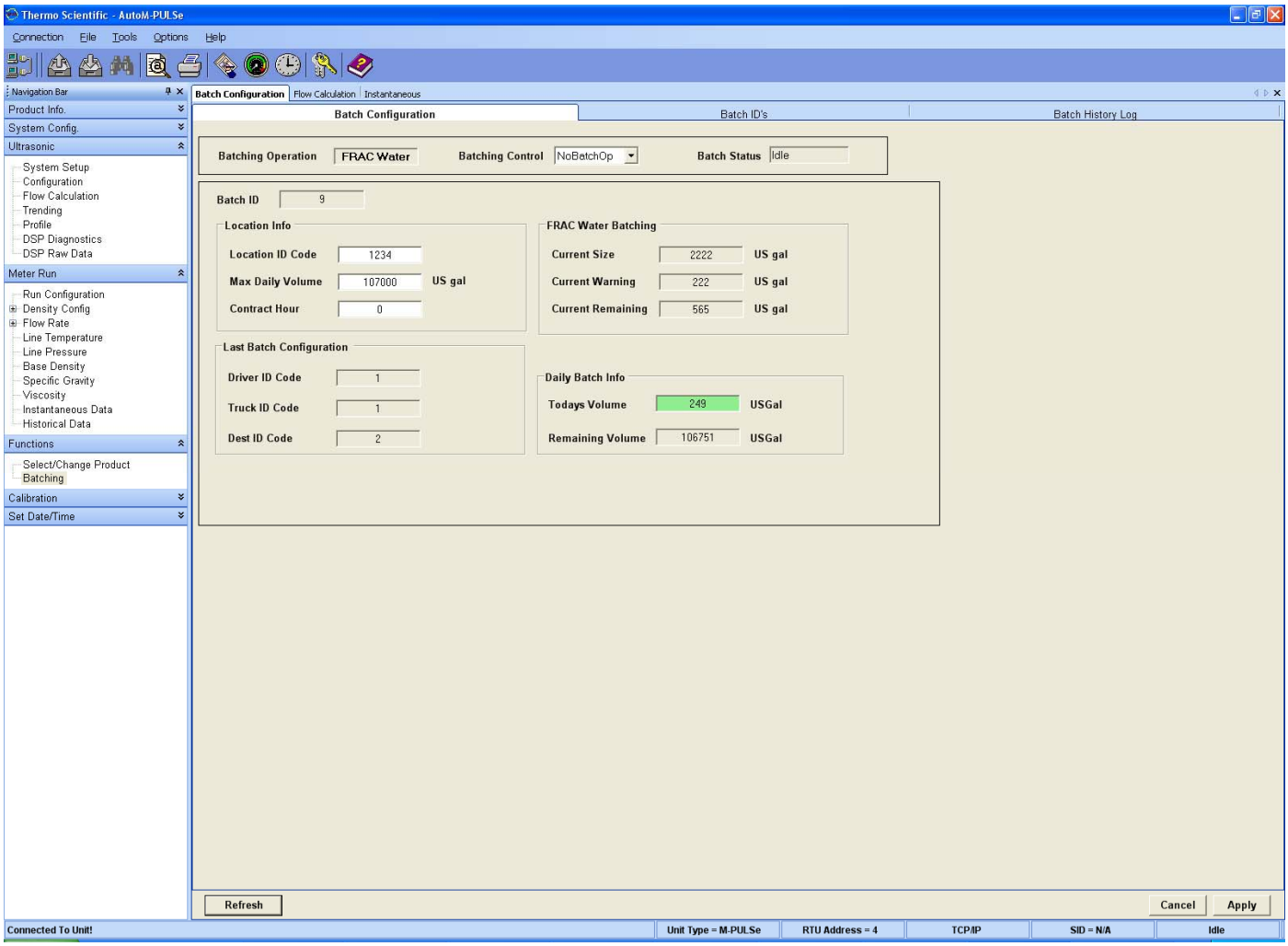
Due to the reduced font panel configuration the screen displayed below must be used to configure the TCPIP port on the M-PULSe flow computer.



Batch Configuration

The screen displayed below can be used to set up location ID, max daily volume, and contract hour for the collection point.

Data for the current site status can also be viewed for information purposes only.



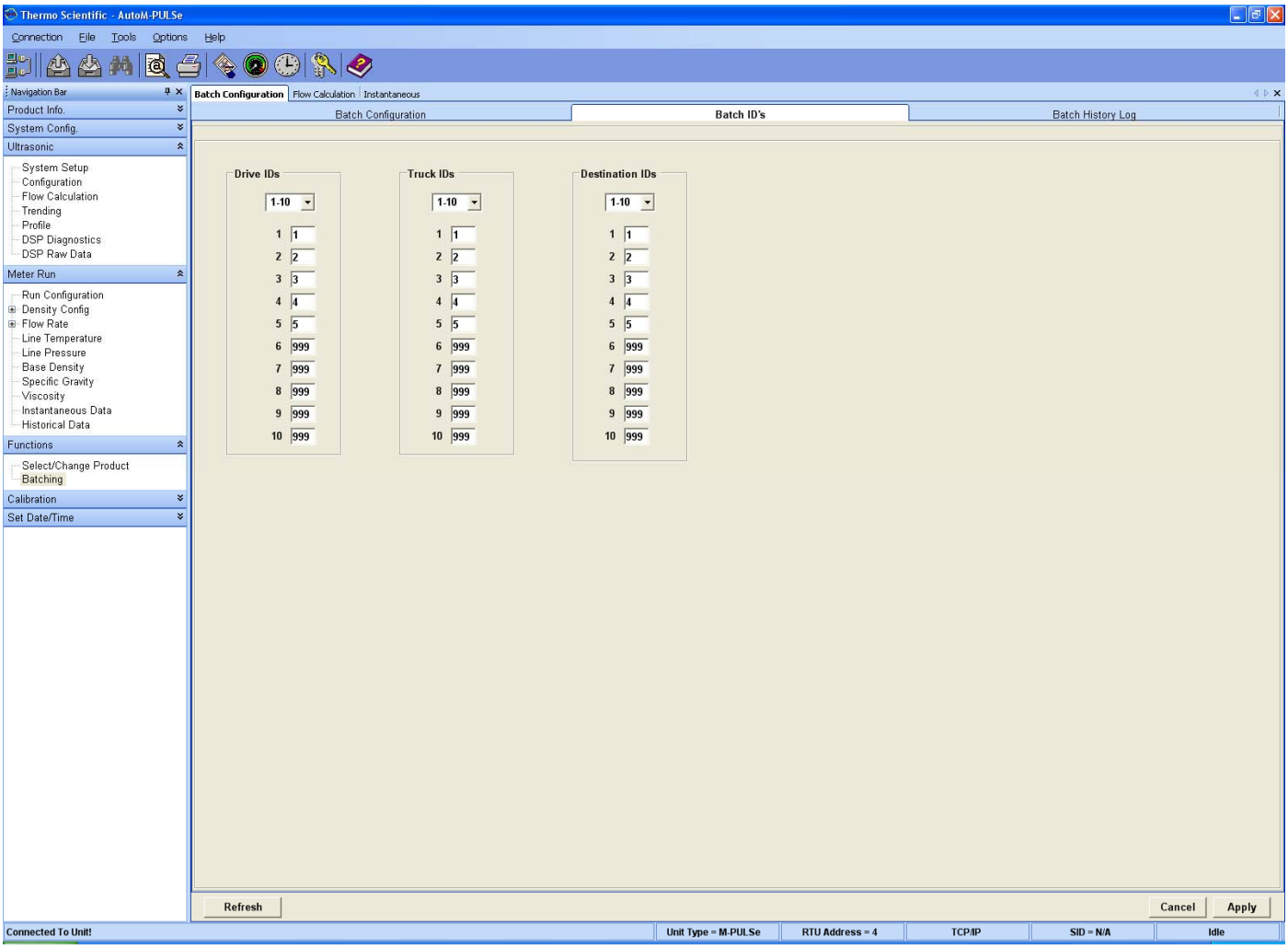
Note Today's Volume will be displayed on a green background if the volume extracted for the day is below the Max Daily Volume. Should this be exceeded the displayed total will have a red background. ▲

Batch IDs

The screen displayed below can be used to configure up to 100 driver, truck, and destination IDs for the extraction site.

After a cold start, the M-PULSe will default the driver IDs from 0 to 99, truck IDs from 100 to 199, and the destination IDs from 200 to 299.

Setting an ID to 999 will effectively mark the last valid ID for a site. In the example below only five driver, truck, and destination IDs are required. In this case, entries 6 and above can be set to 999 to mark the end of the ID list.

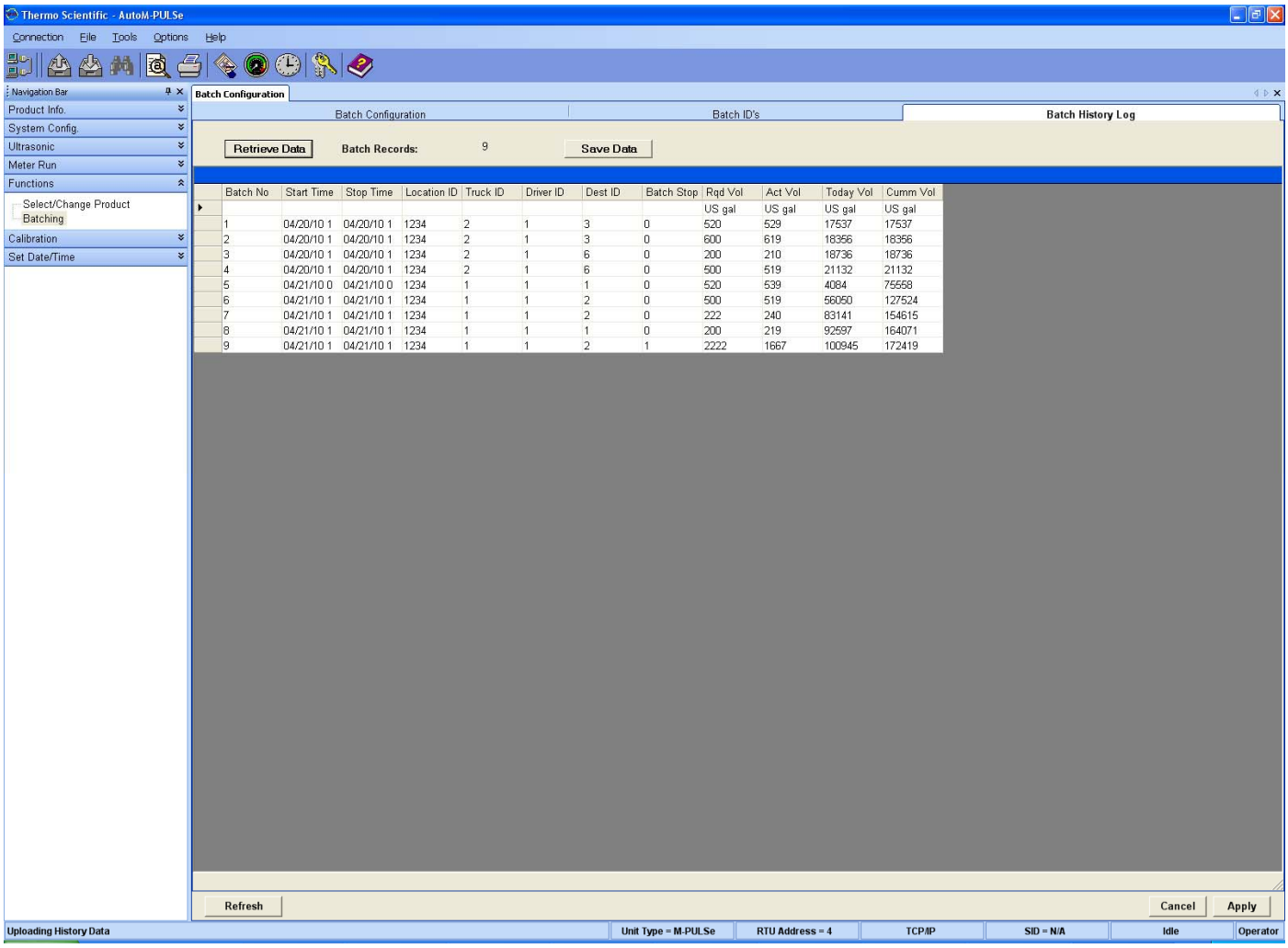


Note If the first ID entry is set to 0 then validation for that ID will not be performed. ▲

Batch History

As each batch is closed on the M-PULSe a record is written to the batch history log. The following screen can be used to retrieve, view, and save the stored history of all batch activity at the extraction site.

Note A maximum of 840 batches can be held before the earliest batch record is overwritten. ▲


Thermo Scientific - AutoM-PULSe
Connection File Tools Options Help
Navigation Bar
Product Info.
System Config.
Ultrasonic
Meter Run
Functions
Select/Change Product Batching
Calibration
Set Date/Time
Batch Configuration
Batch Configuration
Batch ID's
Batch History Log
Retrieve Data
Batch Records: 9
Save Data
Batch No | Start Time | Stop Time | Location ID | Truck ID | Driver ID | Dest ID | Batch Stop | Rqd Vol | Act Vol | Today Vol | Cumm Vol
US gal | US gal | US gal | US gal
1 04/20/10 1 04/20/10 1 1234 2 1 3 0 520 529 17537 17537
2 04/20/10 1 04/20/10 1 1234 2 1 3 0 600 619 18356 18356
3 04/20/10 1 04/20/10 1 1234 2 1 6 0 200 210 18736 18736
4 04/20/10 1 04/20/10 1 1234 2 1 6 0 500 519 21132 21132
5 04/21/10 0 04/21/10 0 1234 1 1 1 0 520 539 4084 75558
6 04/21/10 1 04/21/10 1 1234 1 1 2 0 500 519 56050 127524
7 04/21/10 1 04/21/10 1 1234 1 1 2 0 222 240 83141 154615
8 04/21/10 1 04/21/10 1 1234 1 1 1 0 200 219 92597 164071
9 04/21/10 1 04/21/10 1 1234 1 1 2 1 2222 1667 100945 172419
Refresh
Cancel
Apply
Uploading History Data
Unit Type = M-PULSe
RTU Address = 4
TCP/IP
SID = N/A
Idle
Operator

On this screen, pressing the Retrieve Data button will display the batch history. Pressing the Save Data button will allow an operator to save the retrieved data as a csv file for import into a spreadsheet.

See “Batch History Records” for more extensive details on the batch retrieval process for third-party Modbus master systems.

Chapter 4
Batch History Records

When a batch is closed the following information is stored in the Batch History Log:

Table 4–1. Batch log record

Index	Item	Description
0	Batch No.	Batch identifier incremented automatically after batch closed
1	Start Date	Date batch was started
2	Start Time	Time batch was started
3	Stop Date	Date batch was closed
4	Stop Time	Time batch was closed
5	Location ID	Location ID for extraction site
6	Truck ID	User entered Truck ID Code
7	Driver ID	User entered Driver ID Code
8	Destination ID	User entered Destination ID Code
9	Batch Stop	Reason for batch closure 0 – Automatic batch volume reached 1 – Manual via front panel 2 – Manual via digital input 3 – M-PULSe power cycled
10	Rqd Volume	User entered requested volume
11	Actual Volume	Actual volume taken during batch
12	Today Volume	Volume taken today (reset to 0 at contract hour)
13	Cum. Volume	Total volume extracted from site since totals last reset

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Chapter 5
Batch Log Collection

Batch Record Index

Modbus Register 6031 can be used to determine the index value for the last batch record.

Note Batch records start from Index 1. ▲

Modbus data is transferred in Enron Modbus format whereby one floating point value is one register. Therefore, to determine the number of records available the following command response sequence will occur:

Request No. Records

Addr	Fn	Offset	No Regs	CRC
04	03	17 8E	00 01	E1 C0

Response from M-PULSe

Addr	Fn	#Bytes	Record Pointer	CRC
04	03	04	41 20 00 00	BA 05

Where

41 20 00 00 indicates the next record to be written will be at Index 10. Therefore, nine records from 1–9 are available for retrieval.

Batch Record Collection

M-PULSe stores the batch archive data into fixed length arrays. Using Modbus, these arrays are collected a single record at a time with Modbus function 03 and Offset 703 used to retrieve the data.

Note The register field is used to address the individual archive array record. ▲

For example, to retrieve the batch held in Record Index 5:

Request Record 5

Addr	Fn	Offset	No Regs	CRC
04	03	02 BF	00 05	B5 C0

Response from M-PULSe

Addr	Fn	#Bytes	Batch No.	Start Date	Start Time	Stop Date	Stop Time
04	03	38	40 A0 00 00	47 24 7E 00	44 4B 80 00	47 24 7E 00	44 63 00 00

Location ID	Truck ID	Driver ID	Dest ID	Batch Stop	Rqd Volume
44 9A 40 00	3F 80 00 00	3F 80 00 00	3F 80 00 00	00 00 00 00	00 00 02 08

Act. Volume	Today Vol	Cum. Vol	CRC
00 00 02 1B	00 00 0F F4	00 01 27 26	C6 69

Note Record items are returned as IEEE 754 floating point numbers except for totals which are returned as 32-bit integers. ▲

In the above example the returned record was as shown below.

Item	Data Returned	Value
Batch No.	40 A0 00 00	5
Start Date	47 24 7E 00	42110 [04/21/10]
Start Time	44 4B 80 00	814 [00:08:14]
Stop Date	47 24 7E 00	42110 [04/21/10]
Stop Time	44 63 00 00	908 [00:09:08]
Location ID	44 9A 40 00	1234
Truck ID	3F 80 00 00	1
Driver ID	3F 80 00 00	1
Destination ID	3F 80 00 00	1
Batch Stop	00 00 00 00	0 – Automatic
Rqd Volume	00 00 02 08	520
Actual Volume	00 00 02 1B	539
Today Volume	00 00 0F F4	4084
Cum. Volume	00 01 27 26	75558

Frac Water Outputs and Inputs

The following outputs and inputs have been made available for the frac water application:

Table 5–1. M-PULSe outputs for frac water application

M-PULSe I/O	Water Frac Functionality	Type
SSR1-SSR2	Flow Valve Control	Solid State Relay Contact Closure
VALVE 1*	Total Daily Volume Exceeded	0.0 – 3.3 V
VALVE 2*	End Batch Warning	0.0 – 3.3 V
RELAY 1	HI Flow/Input Variable Alarm	Relay Contact Closure
RELAY 2	Ultrasonic Fault	Relay Contact Closure

*Depending upon status indicator user may need to supply an interface board to convert low voltage output.

Table 5–2. M-PULSe inputs for frac water application

M-PULSe I/O	Water Frac Functionality	Type
SPHERE 1	Manual Stop Batch	Contact Input GND to Stop Batch

Additional Modbus Registers

The following Modus registers have been assigned for the frac water application.

Table 5–3. Modbus registers for batch configuration

Register Number	Description	R/W	Write Access	Comments
10601	Batch Inhibit	R/W	Ops	0 – Allow batching if volume exceeded 1 – Inhibit batching if volume exceeded
10602	Contract Hour	R/W	Eng	Hour at which Today's Totals are reset
10603	Location ID	R/W	Eng	Location ID Code
10604	Truck ID	R/W	Ops	User entered Truck ID
10605	Driver ID	R/W	Ops	User entered Driver ID
10606	Destination ID	R/W	Ops	User entered Destination ID
10607	Max Daily Volume*	R/W	Eng	Maximum Daily Volume For Site
10608	Batch Next Size*	R/W	Ops	Next Batch Size
10609	Batch Next Warning*	R/W	Ops	Next Batch Warning
10610	Current Batch ID	R/W	Ops	Current Batch ID Number – Automatically incremented on batch completion
10611	Batch Control	R/W	Ops	0 – No action 1 – Stop batch
10612	Batch Status	R	N/A	Current Batch Status
10613	Current Batch Size*	R	N/A	Current Batch Requested Size
10614	Current Batch Warning*	R	N/A	Current Batch Warning value
10615	Current Batch Remaining*	R	N/A	Remaining Volume this batch
10616	Today's Volume*	R	N/A	Volume Extracted Today
10617	Volume Remaining Today*	R	N/A	Volume Remaining to be Extracted Today

*Data transmitted back through Modbus as a long integer, not a floating point number.

Table 5–4. Driver ID table

Register Number	Description	R/W	Write Access	Comments
6401	Table Index	R/W	Ops	Index into Driver IDs [0,10,20,30 etc]
6402	Driver ID 1 + Index	R/W	Eng	Driver ID at Table Index + 1
6403	Driver ID 2 + Index	R/W	Eng	Driver ID at Table Index + 2
6404	Driver ID 3 + Index	R/W	Eng	Driver ID at Table Index + 3
6405	Driver ID 4 + Index	R/W	Eng	Driver ID at Table Index + 4
6406	Driver ID 5 + Index	R/W	Eng	Driver ID at Table Index + 5
6407	Driver ID 6 + Index	R/W	Eng	Driver ID at Table Index + 6
6408	Driver ID 7 + Index	R/W	Eng	Driver ID at Table Index + 7
6409	Driver ID 8 + Index	R/W	Eng	Driver ID at Table Index + 8
6410	Driver ID 9 + Index	R/W	Eng	Driver ID at Table Index + 9
6411	Driver ID 10 + Index	R/W	Eng	Driver ID at Table Index + 10

Table 5–5. Truck ID table

Register Number	Description	R/W	Write Access	Comments
6412	Table Index	R/W	Ops	Index into Truck IDs [0,10,20,30 etc]
6413	Truck ID 1 + Index	R/W	Eng	Truck ID at Table Index + 1
6414	Truck ID 2 + Index	R/W	Eng	Truck ID at Table Index + 2
6415	Truck ID 3 + Index	R/W	Eng	Truck ID at Table Index + 3
6416	Truck ID 4 + Index	R/W	Eng	Truck ID at Table Index + 4
6417	Truck ID 5 + Index	R/W	Eng	Truck ID at Table Index + 5
6418	Truck ID 6 + Index	R/W	Eng	Truck ID at Table Index + 6
6419	Truck ID 7 + Index	R/W	Eng	Truck ID at Table Index + 7
6420	Truck ID 8 + Index	R/W	Eng	Truck ID at Table Index + 8
6421	Truck ID 9 + Index	R/W	Eng	Truck ID at Table Index + 9
6422	Truck ID 10 + Index	R/W	Eng	Truck ID at Table Index + 10

Table 5–6. Destination ID table

Register Number	Description	R/W	Write Access	Comments
6423	Table Index	R/W	Ops	Index into Dest IDs [0,10,20,30 etc]
6424	Dest ID 1 + Index	R/W	Eng	Dest ID at Table Index + 1
6425	Dest ID 2 + Index	R/W	Eng	Dest ID at Table Index + 2
6426	Dest ID 3 + Index	R/W	Eng	Dest ID at Table Index + 3
6427	Dest ID 4 + Index	R/W	Eng	Dest ID at Table Index + 4
6428	Dest ID 5 + Index	R/W	Eng	Dest ID at Table Index + 5
6429	Dest ID 6 + Index	R/W	Eng	Dest ID at Table Index + 6
6430	Dest ID 7 + Index	R/W	Eng	Dest ID at Table Index + 7
6431	Dest ID 8 + Index	R/W	Eng	Dest ID at Table Index + 8
6432	Dest ID 9 + Index	R/W	Eng	Dest ID at Table Index + 9
6433	Dest ID 10 + Index	R/W	Eng	Dest ID at Table Index + 10

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Chapter 6
Getting Help

The local representative is your first contact for support and is well equipped to answer questions and provide application assistance. You can also contact Thermo Fisher directly.

1410 Gillingham Lane Sugar Land, TX 77478 USA Tel: +1 713-272-0404 Fax: +1 713-272-2272	14 Gormley Industrial Avenue Gormley, Ontario L0H 1G0 CANADA Tel: +1 905-888-8808 Fax: +1 905-888-8828	Ion Path, Road Three Winsford, Cheshire, CW7 3GA UNITED KINGDOM Tel: +44 (0) 1606 548700 Fax: +44 (0) 1606 548711
Room 1010-1019 Ping An Mansion No 23 Jing Rong St Beijing 100032 CHINA Tel: +86 (10) 5850-3588 Fax: +86 (10) 6621-0847	A-101, 1CC Trade Tower Senapati Bapat Road Pune 411 016 INDIA Tel: +91 (20) 6626 7000 Fax: +91 (20) 6626 7001	**On the Web** www.thermo.com

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Index

A

Another Batch screen, **2-5**
AutoMPULSe
  frac water batching screens
    Batch Configuration screen, **3-2**
    Batch History screen, **3-4**
    Batch ID screen, **3-3**
    Set/Edit TCP/IP, **3-1**

B

batch closures
  external input closure, **2-6**
  forced closure, **2-6**
  keypad closure, **2-6**
Batch Completion screen, **2-5**
Batch Configuration screen, **3-2**
Batch End Warning screen, **2-5**
batch history, **4-1**
  record collection, **5-1–5-3**
  retrieving data, **3-4**
  saving data, **3-4**
Batch History screen, **3-4**
Batch ID screen, **3-3**
Batch Info Confirmation screen, **2-3**
Batch Info Setup screens, **2-2**
Batch Size Warning screen, **2-3**
Batching screen, **2-3**

C

contact information, **6-1**
Cumulative Volume screen, **2-4**

D

Daily Volume screen, **2-4**
destination ID
  configuration, **3-3**
Destination ID
  entry via local user interface, **2-2**
driver ID
  configuration, **3-3**
Driver ID
  entry via local user interface, **2-2**

F

Flow Rate screen, **2-4**
frac water batching
  Modbus registers, **5-5–5-7**
  M-PULSe inputs reserved for, **5-4**
  M-PULSe outputs reserved for, **5-4**
  overview, **1-1**
  process flow charts, **1-2–1-5**

I

Idle screen, **2-1**

L

local user interface
  Another Batch screen, **2-5**
  Batch Completion screen, **2-5**
  Batch End Warning screen, **2-5**
  Batch Info Confirmation screen, **2-3**
  Batch Info Setup screens, **2-2**
  Batch Size Warning screen, **2-3**
  Batching screen, **2-3**
  Idle screen, **2-1**
  User Access screen, **2-2**

R

Remaining Volume screen, **2-4**
required batch size, **2-2**

S

Set/Edit TCP/IP screen, **3-1**

T

truck ID
configuration, **3-3**
Truck ID
entry via local user interface, **2-2**

U

User Access screen, **2-2**

Thermo Fisher Scientific
81 Wyman Street
P.O. Box 9046
Waltham, Massachusetts 02454-9046
United States

www.thermofisher.com